DRAFT

ASSESSMENT OF PENTACHLORONITROBENZENE (PCNB) FUNGICIDE USES IN AGRICULTURE

REPORT I

USDA/STATE/EPA ASSESSMENT TEAM OF THE
NATIONAL AGRICULTURAL PESTICIDE IMPACT ASSESSMENT PROGRAM
UNITED STATES DEPARTMENT OF AGRICULTURE

COORDINATED BY THE OFFICE OF ENVIRONMENTAL
QUALITY ACTIVITIES
USDA

April 30, 1978

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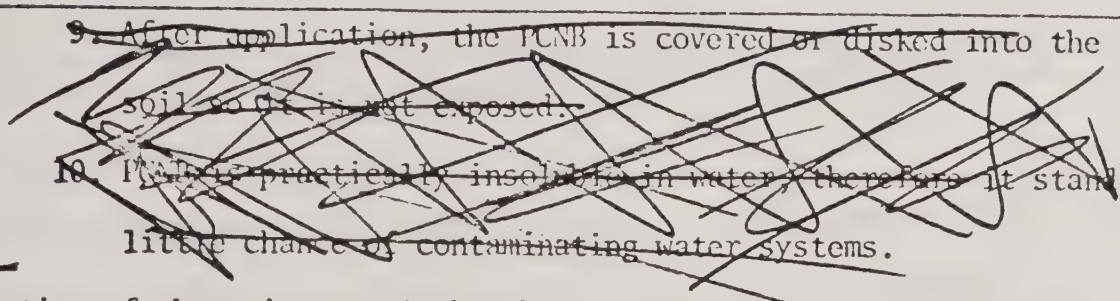
PCNB Rebuttal



9. After application, the PCNB is covered or disked into the soil so it is not exposed.

10. PCNB is practically insoluble in water, therefore it stands little chance of contaminating water systems.

Evaluation of the triggers--Although the committee is in no position to evaluate the triggers, it is possible to emphasize what has been done relevant to the validity of the triggers and to include new information.

A. In regard to bioaccumulation and metabolism in animals, in the study of Finegan et al (1958) in which a determination was made of the amount of PCNB stored in the fat of male and female rats when fed 0, 63.5, 1250, or 2500 ppm PCNB for 3 months, the results showed a dose-related increase in PCNB content of fat tissue. Tissues of sacrificed rats were analyzed by neutron activation of chlorine. Though increasing quantities of chlorine were found in rats fed increasing amounts of the material, it was pointed out by Kuchar et al (1969) that the neutron activity process was not adequate for determining residues of PCNB or its metabolites in animals. Borzellaca et al (1971) stated that the residue in the fat originally identified as PCNB consisted mostly of PCB and HCB.

In the Borzellaca et al (1971) experiment in which cows were given PCNB orally (in gelatin capsules) at levels of 0, 0.1, 1.0, or 10.0 ppm for 12 to 16 weeks, milk and subcutaneous fat were analyzed. In the milk, there was little indication of dose-level-related changes and in the fat PCA (2,3,4,5,6 pentachloroaniline) stabilized at .1 ppm at the highest level fed. The residues of PCA (probably a misprint and should have been PCB (2,3,4,5,6 pentachlorobenzene) PCNB and MPCPS (S-methyl pentachlorophenyl sulfide) were negligible or non-detectable. It was stated that "the levels of detectability for control and treated samples

differed from week to week; consequently, the results are difficult to assess accurately."

In the Borzellaca (1971) study on dogs, they were fed 0,5,30,180, or 1080 ppm PCNB in their diets for 2 years, after which the presence of PCNB, PCB, HCB, PCA and MPCPS in the liver, kidney, fat and feces was detected for all dose levels but 1080 ppm. PCNB was not detected in the liver, kidney or fat tissues but was detected in the feces.

Goursand et al (1972) studied the relationship of HCB (hexachlorobenzene) residues in endive roots with the HCB levels in milk from cows eating the roots. The authors concluded that the HCB contamination in the milk was linked to the application of PCNB to the endive but they speculated that the source of the HCB was from the original formulation rather than from the degradation of PCNB. In these studies, PCNB residues were negligible for all samples.

On page 12 of the EPA (OPP-30,000/17) Pesticide Programs Notice of Rebuttable Presumption Against Registration and Continuing Registration of Pesticide Products containing Pentachloronitrobenzene (PCNB) reports are listed of HCB being assimilated in sheep, chickens, Japanese quail, kestrels, rats, aquatic organisms, fish, poultry products, birds, edible animal tissues, and human milk and tissues. Inasmuch as no mention is made of the sources of HCB, it is questioned as to whether this information should be included in a report on PCNB.

In summary of the triggers on the bioaccumulation and metabolism in animals, PCNB has not been shown to accumulate in animals in the experiments listed. Other materials such as PCA, PCB, HCB and MPCPS appear not to be products of metabolism of PCNB but occur in the animal tissues because of being contaminants in the PCNB samples used.

different from work on peaks, comes out ...

face. accurately)."

In the Borzelleca (1971) study on dogs, they ...

1080 ppm PCNB in ... for 2 years, after ...

PCNB, ... HCB, PCB was ... in ...

detected for all dose levels but 1080 ppm, ...

, kidney or fat tissues but was detected in the ...

Gorbach et al. (1971) studied the relationship ...

(o-zone) residues in ... with ...

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should be included in a report on PCNB.

f the criteria ... and metabolism

... accumulate in animals ...

..., HCB and ...

in the animal tissues ...

B. In regard to toxicity of PCNB, in feeding tests by Finnegan et al (1958) 10 mongrel dogs were fed doses up to 2.5 g/kg and no deaths resulted though half the dogs vomited. Three mongrel dogs on diets of 25, 200, or 1000 ppm for one year did not show any growth inhibition or significant hemalotogical or histopathological changes. The same authors reported studies in which 10 male and 10 female rats were fed PCNB at rates of 0, 25, 100, 300, 1000 or 2500 ppm. Deaths did not correlate with dose of PCNB though female rats showed a slight growth suppression at 100 ppm and above. Hematological values were within normal ranges and lung abscesses and fatty changes in the liver did not correlate with PCNB dose. There was accelerated growth rate in male rats, particularly at 25 ppm.

Borzellaca et al (1971) using male New Zealand rabbits in percutaneous studies with PCNB at rates of 10.0 ml/kg and 13.3 ml/kg of a 30% solution applied to 10 rabbits with intact skin and 10 rabbits with abraded skin found no indications of toxicity or skin irritation during 14 days following treatment. They also found in a dog study using beagles approximately 4.5 months old and fed 0, 5, 30, 180 or 1800 ppm for 2 years that there were no dose related effects on urine analysis, blood chemistry, mortality, body weight, food consumption or estrus cycle. There was a significant decrease in the ratio of volume of packed red blood cells to the volume of whole blood in male dogs at 30 and 180 ppm but no change in males fed 1080 ppm. Dogs sacrificed at 1 year showed no treatment related lesions and though dogs sacrificed after 2 years showed cholestatic hepatasis with secondary bile nephrosis at feeding doses of 180 ppm and 1080 ppm, the authors considered these reversible.

In regard to toxicity of [illegible] Reddy, [illegible] Pilgrim

10 control dogs were fed doses up to [illegible] [illegible] no death [illegible]

d though [illegible] the dogs treated. Those monitored [illegible] diets [illegible]

1000 [illegible] year did not show any growth [illegible]

cant hematological or histopathology changes [illegible]

ed studies in which 10 male and [illegible] female [illegible] fed PCNB

of 0, 25, 100, 500, 1000 [illegible] 2500 ppm, for [illegible]

dose of PCNB through female rats [illegible] growth [illegible]

0 ppm and above. Hematological values were [illegible] normal ranges

ung abscesses and fatty changes in the liver [illegible]

dose. There was accelerated growth rate in male rats, [illegible]

Borzelleca et al (1971) using male Ng. [illegible] [illegible]

ate studies with PCNB at rates of 10 [illegible] mg/kg and 13.5 mg/kg of a [illegible]

[illegible] applied to [illegible] rabbits [illegible] [illegible] [illegible] with

braded skin found no indication of toxicity or skin irritation during

following treatment. They also found [illegible] [illegible]

gle approximately 4.5 months old and fed [illegible] [illegible] [illegible] ppm

[illegible] that there were no dose related effects [illegible] [illegible] and [illegible]

mortality, body weight, food consumption [illegible]

[illegible] decrease in the rate of [illegible]

[illegible] [illegible] of [illegible] blood in [illegible] dogs at [illegible]

[illegible] males fed 1080 ppm. They [illegible]

[illegible] [illegible] and [illegible] dogs [illegible]

[illegible] [illegible] [illegible]

[illegible] [illegible]

In FAO-WHO report (1970) 10 male and 10 female rats fed PCNB at the rate of 0, 1,000, 5,000 or 10,000 ppm for 90 days showed a growth rate only slightly less than controls at 5,000 ppm and a lower growth rate at 10,000 ppm.

In the Finnegan et al (1958) study, groups of 7 male and 7 female rats were fed diets containing 0, 63.5, 635, 1250, 2500 or 5000 ppm PCNB. In this study body weights of males were depressed significantly at the 2500 ppm level. Males and females at 5000 ppm were killed at the end of 2 weeks. At 1250 and 2500 ppm levels, the kidney-to-body weight ratios in male rats showed significant increases.

In a study conducted by Farbwerke Hoechst HG (FAO/WHO 1970) groups of 3 males and 3 female dogs were fed PCNB at 0, 500, 1000, and 5000 ppm for 2 years. Liver changes occurred in all groups and were dose related. At 5000 ppm, fibrosis, narrowing of hepatic cells, thick leucocyte infiltration and increased size of the periportal areas resulted. The highest level also produced atrophy of bone marrow and reduced hemato-poiesis.

In summarizing the results of the experiments reported on toxicity of PCNB, all of the tests done except two showed little or no toxic effects of PCNB to animals used. In the two studies mentioned above, deleterious effects were recorded but it should be pointed out that the feeding levels at which these occurred (1250, 2500 or 5000) are extreme-ly high.

The experiments reporting oncogenicity also need to be reviewed critically. In the Hazelton Carcinogenesis Bioassay of PCNB, 50 male and 50 female rats and mice were used. Male rats were fed 5000 to 7500 ppm in one group and 10,000 to 15,000 ppm in another group for 14 weeks

FAO-WHO report (1970) ... rate of 0, 1,000, 5,000 or 10,000 ppm for 90 days showed a ... only slightly less than control ... 5,000 ppm and a lower ... 10,000 ppm.

In the Finnegan et al (1958) study, groups ... male and ... female ... were fed diets containing 0, ..., 625, ..., ... ppm PCNB ... body weights of males ... depressed significantly at the ... ppm level. Males and females at 5000 ppm were killed ... end of ... At 1250 and 2500 ppm levels, the kidney-to-body weight ratios ... rats showed significant increases.

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... reporting mutagenicity ... need to be ... ... of PCNB, 10 mice ... ... group for ... weeks

These were then reduced to the lower dosage for 64 weeks. Female rats were then reduced to the lower dosage for 64 weeks. Female rats were fed 11,000 or 22,000 ppm for 14 weeks when these doses were reduced to 7250 and 14,500 ppm respectively for the remaining 64 weeks. Low dose male mice received 1075 to 3000 ppm whereas high dose male mice received 2150 to 6000 ppm. Low dose female mice were fed 2320 to 4500 ppm whereas high dose female mice received 4640 to 9000 ppm. All mice were fed for 78 weeks. The results in carcinomas and malignant tumors were not statistically significant. According to the report carcinomas of the liver developed in 8 of 18 mice indicating a significant difference over those in the control. However, when the National Cancer Institute (1978) analyzed the data from these experiments, it reported (page B-3) that 8 of 35 mice developed liver carcinoma and that under the conditions of the experiment, this was not significantly different from the control. In fact, the National Cancer Institute concluded after analyzing this study "that under the conditions of this bioassay, PCNB was not carcinogenic in either Osborne-Mendel rats or B6C 3F1 mice."

The Mouse Study of the Central Institute for Nutrition and Food Research (Van der Heyden and Til 1974) as reported in the EPA Pesticide Program on PCNB includes information indicating that Albert (1977) concluded there were significantly more fibromas and fibrocarsomas in female mice fed 1200 ppm than in female controls. However, no conclusions by the Central Institute for Nutrition and Food Research were given in the EPA PCNB report.

Albert (1977) also analyzed the results of the Central Institute for Nutrition and Food Research in its rat study and found significantly more lymphoretic tumors of the lung in males ingesting 100 ppm than the

se were then reduced to the lower dosage for [illegible] weeks. The

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[illegible] or 22,000 ppm for 14 weeks when these doses were reduced [illegible]

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[illegible] under the conditions of this bioassay, [illegible] carcinogenic

Osborne-Mendel rats or [illegible] mice."

[illegible] Study of the Central Institute for Nutrition and [illegible]

h (Van der [illegible] and [illegible]) as reported in the [illegible]

on PCNB includes information indicating that [illegible] (1977) [illegible]

[illegible] were significantly more fibromas and fibrosarcomas [illegible]

ice fed 1500 ppm than in female controls. However, no [illegible]

ational Institute of Nutrition and Food Research were given [illegible]

controls. It is interesting that tissue examination were made only from 20 males and females in the controls and 1200 ppm groups and were limited to the liver and to grossly visible tumors or lesions suspected of being tumors for all other animals. Thus the only lesions on the lungs diagnosed were those large enough to be seen by the naked eye. Others were not detected and could have made a difference. Also, no conclusions by the Central Institute were recorded for this study in the EPA RPAR.

Several questions can be raised about the Innes Mouse Study (Innes et al 1969). The maximum tolerated dosage was fed unweaned mice from the 7th day to the 28th day at which time they were fed 1206 ppm. Is it a fair or logical experiment to treat extremely young animals with the maximum tolerable dose? Also why were not the conclusions of Innes et al included in the EPA RPAR? It also should be noted that although the purity of PCNB was not reported, it was thought to be 88% PCNB and 11% HCB. The latter is an excessively high rate for that material considering PCNB now averages approximately 0.6 HCB.

The experiment on the Tumor Initiating Study in Mice (Searle 1966) can hardly be considered valid because after the PCNB applications which lasted 12 weeks, the same mice received croton oil applications for 20 weeks. To make the experiment valid, mice with no PCNB treatment also should have been treated with croton oil for 20 weeks. Inasmuch as this was not done, the conclusions as to the effect of PCNB are invalid.

In summarizing the information given in the oncogenicity triggers, it appears that in some reports, there was no significant carcinogenicity, summarizations by the reporting agencies were not included or the experiments were not validily conducted with regard to PCNB.

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Several questions can be raised about the [illegible] Mouse Study [illegible] t al 1969). The maximum tolerated dose [illegible] [illegible] day to the 28th day at which time they [illegible] 1200 [illegible] [illegible] or logical equivalent to treat extremely young animals with the [illegible] mum tolerable dose? Also why were not the conclusions of [illegible] [illegible] uded in the [illegible]? It also should be noted that although the [illegible] ty of PCNB was not reported, it was thought to be [illegible] and 11% [illegible] latter is an excessively high [illegible] for that material considering [illegible] now averages approximately 0.6 HCB.

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[illegible] in the oncogenicity category, [illegible] no significant carcinogenic [illegible] [illegible] cies were not included in the [illegible] to PCNB.

and turf.

8. PCNB gives control of Typhula, Fusarium, Puccinia (rusts) and Ustilago (smuts) on turf grasses.

9. PCNB ~~, when used is nearly always~~ is usually added to the soil as a pre-plant treatment or ~~is added~~ at the time of seeding or planting, or is used as a seed treatment material. This means that in normal useage, nearly all of the PCNB used is disked into soil or covered with it leaving practically none exposed.

10. PCNB is used at extremely low rates. ~~In~~ most PCNB applications for seed and turf are seed treatment up to 5 ounces active ingredient may be used per acre. In-furrow treatments use only ~~a pound or up to~~ 1-5 pounds per acre.

11. PCNB is insoluble in water meaning that it does not enter water systems.

~~12. PCNB has a short life span in soil.~~

~~13. It is used only a short period of time each year and usually only once on a crop.~~

14. Workers handling PCNB are exposed only for brief periods such as opening and pouring treated seed or the fungicide into hopper boxes. Very few individuals are involved in the handling of the material.

15. Much of the PCNB used is either as a seed treatment or granular formulation, both of which are virtually dustless.

16. Of the triggers, few show real hazards and those that do used PCNB at relatively high dosages.

17. Some of the triggers indicate that contaminants in PCNB are hazardous, particularly HCB. This material has been reduced to 0.5% or less in commercially available PCNB.

18. PCNB continues to be a relatively inexpensive pesticide to use.

PCB Spill Control and Cleanup Procedures

1. Spills (small) on hard surfaces.

2. PCB-contaminated absorbent materials (such as wood, paper, or cloth) resulting from the cleanup of spills.

3. PCB-contaminated soil or other porous materials.

4. Items or equipment (such as rags, containers, or tools) contaminated with PCBs.

5. Liquids containing PCBs.

6. Electrical equipment containing PCBs.

7. Transformers and capacitors.

8. Other PCB items.

19. Because PCNB has a limited effective range, it will do little to upset the biological ecosystems where it is used.

Introduction

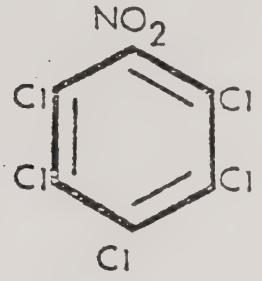
~~Introduction~~. On October 13, 1977 a Rebuttable Presumption Against Registration and Continued Registration was issued regarding the fungistat Pentachloronitrobenzene (also known as PCNB and Quintozene). The purpose of this report is to bring together information regarding the risks and the benefits of this ~~fungistat~~.

The major uses of Pentachloronitrobenzene, henceforth referred to as PCNB in this paper, are prevention of seedling diseases of cotton, the control of southern root rot of peanuts, the control of seedling and root rots of various vegetables, the control of several diseases of turf grasses and the prevention and control of various soil-borne diseases of ornamental plants. PCNB is used ~~in~~ control ~~soil-borne~~ plant pathogens and is applied as a seed treatment material, as a soil application prior to planting followed by discing ~~on~~ as a drench on growing plants. Because of its effectiveness and wide use in the production of many agricultural crops, it is necessary to weigh the benefits of this material and compare them with the risks ~~and the fact that PCNB has been found to exceed certain risk criteria~~.

Physical and Chemical Properties of PCNB

PCNB

pentachloronitrobenzene



$C_6Cl_5NO_2$

Properties:	Colorless crystalline needles practically insoluble in water; soluble in carbon disulfide, benzene, chloroform, carbon tetrachloride; slightly soluble (2%) in ethanol and methanol; pH 2.0 to 6.0; stable under normal conditions; technical, characteristic odor; MW 295.4
Compatibility:	Compatible with most pesticides: captan, dithiocarbamates, antibiotics, aldrin, dieldrin, endrin, toxaphene, DDT, Nemagon, and fertilizer; compatible with dinitros when they are mixed with water prior to adding PCNB
Mammalian toxicity:	Acute oral (rat) $LD_{50} > 1200$ mg/kg
Formulations:	10%, 20%, 40%, dusts, 75% WP, 24% EC (2 lb/gal)
Phytotoxicity:	May reduce rooting of some plants; most plants may be planted immediately after soil application
Uses:	Soil treatment for diseases caused by species of Botrytis, Rhizoctonia, Sclerotinia, Sclerotium, and a few other genera; seed treatment and bulb dip in combination with other fungicides
Trade names:	Best Turf Fungicide, Botrilex, Brassicol, Folosan, Fungiclor, Pent-o-bunt, quintozene,* Terraclor, Terracap (+ captan), Tilcarex, Tritisan, Panterra (+ methylmercury dicyandiamide), Orthocide Soil Treater X (+ captan)
Approximate price:	20% dust: $27/cwt 50-lb bag, 75% WP: 83¢/lb, 30 gal (24% EC) $3.10/gal
Basic producer:	Olin Mathieson Chem Corp

*British Standards Institute common name.

pentachloronitrobenzene

$C_6Cl_5NO_2$

Colorless crystals or needles; [illegible], soluble in [illegible] soluble in carbon disulfide, benzene, [illegible] tetrachloride; slightly soluble [illegible] pH 2.0 to 6.0, stable under [illegible] characteristic odor; MW [illegible]

Compatible with [illegible] fungicides, captan, [illegible] antibiotics, [illegible] dieldrin, [illegible] Nemagon, and fertilizers [illegible] when they are mixed with water prior to adding PCNB

Acute oral (rat) LD_{50} [illegible]

[illegible]

May reduce rooting of some plants; [illegible] plants may be planted immediately after soil application

Soil treatment for diseases caused by species of Botrytis, Rhizoctonia, Sclerotinia, Sclerotium, and [illegible] seed treatment and [illegible] dip in combination with [illegible]

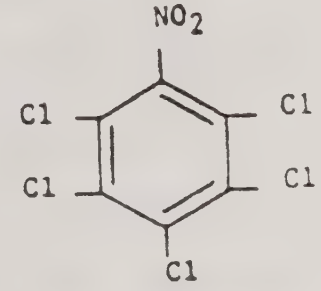
Best Turf Fungicide, Brillex, Brassicol, Folosan, Fungiclor, [illegible] Terraclor, Terracoat [illegible] [illegible] (pentachloronitrobenzene) [illegible]
[illegible]

Biological and Environmental Fate

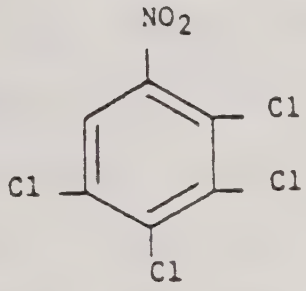
The half-life of PCNB in 3 soil types at 25° C has been shown to range from 4.7 to 9.7 months (60). PCNB is not very soluble and does not leach very easily from the soil (48) as demonstrated by soil TLC, which confirms that PCNB is relatively immobile (33).

Loss of PCNB from soil is due primarily to microbial degradation. Many microorganisms have the ability to convert PCNB to pentachloroaniline (PCA) (15), a process favored by flooding (43). Formation of PCA extends fungitoxic activity, a likely result of oxidation by soil microorganisms to produce PCNB (40).

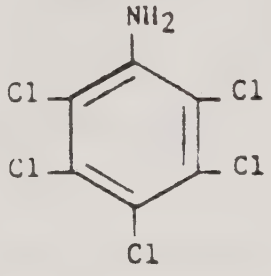
A number of compounds have been identified in PCNB-treated soils (30, 39, 41, 49). These include the following:



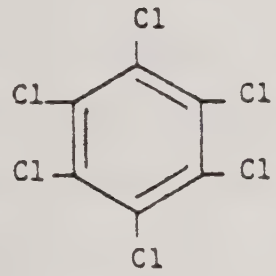
PCNB



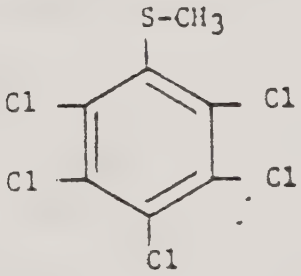
Tetrachloronitrobenzene (TCNB)



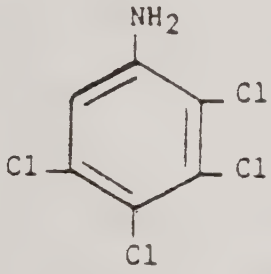
PCA



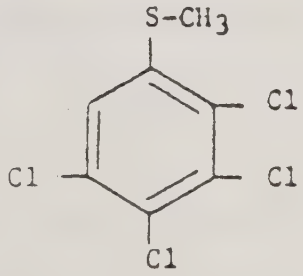
Hexachlorobenzene (HCB)



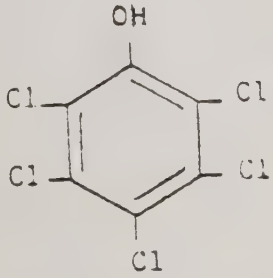
Pentachlorothioanisole (PCTA)



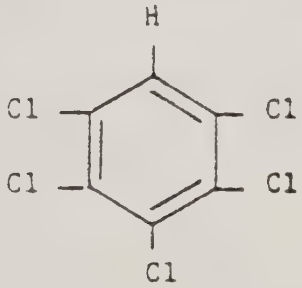
Tetrachloroaniline (TCA)



Tetrachlorothioanisole (TCTA)



Pentachlorophenol (PCP)



Pentachlorobenzene (PCB)

TCNB, HCB and PCB are usually present as impurities in technical PCNB (20). A recent study (41) using ^{14}C-labeled PCNB indicated that under anaerobic conditions a small amount of PCP is produced in PCNB-treated soil. Slightly less than 0.5% of the ^{14}C was recovered as PCP from flooded soils (41). PCNB has been shown to disappear rapidly from soils that were anaerobic from flooding or oxygen exclusion (61). This process is accelerated by organic ammendments (61).

There is some loss of PCNB as well as HCB, PCA, and PCTA by volatilization from aerated soils (14, 39). PCNB has sufficient vapor pressure to diffuse through the soil (27), and fungitoxic concentrations have been found in soil air when PCNB was applied to seed rows or used for seed treatment (53).

Application of PCNB as well as benomyl, captan or thiram increased the amount of exchangeable Mn, Na and Zn in the soil (59). In soil treated with PCNB, the half-~~life~~ lives of other pesticides present ~~has~~ have been extended (40). This is probably due to the degradative enzyme-substrate (pesticides in this case) ratio (40).

The vapor pressure of PCNB is such that one would expect some loss from the soil by volatilization. Photoreduction of PCNB to tetrachlorobenzene is one route of environmental loss of this fungicide (5, 58, 63). UV irradiation of PCNB in various solutions produced a rather slow decomposition (18). The primary reaction was reductive dechlorination (18).

Potatoes grown in PCNB-treated soil contained PCNB, particularly in peels (26). Conversion products were also detected; PCA was the only

one identified (26).

In young cotton plants grown 1 or 2 weeks in soil treated with 300 ppm PCNB, large amounts of PCNB and small amounts of PCB, TCNB, HCB, PCA and PCTA were present in the green parts of the plant (44). There were similar findings in young corn and soybean plants (44).

Rabbits were dosed with 2g unlabeled PCNB by stomach tube, and over a 72-hour collecting period (7):

46 - 62% excreted unchanged in feces

4 - 14% excreted in urine as N-acetyl-S-pentachlorophenylcepteine

12 - 14% excreted in urine as free and conjugated PCA

No PCNB was detected in the milk of a lactating cow fed 5 ppm unlabeled PCNB for 5 days (57). Urine collected from the onset of the experiment until 2 days after the last feeding contained 45% of the PCNB administered (57).

There have been a variety of long-term feeding studies using dogs, rats and cows (13, 50). Most of the PCNB was excreted in the urine and feces. PCNB was present in low quantities or not at all in the tissues of these animals.

In studies (38) using fish exposed to a number of concentrations of Terrachlor (75% ai) for various periods of time, the following L C 50's were reported:

	L C 50	
	Bluegill	Rainbow Trout
	(Lepomis macrochirus)	(Salmo gairdneri)
24 h	0.42 ppm	0.42 ppm
	7.4 ppm	

96 h 0.29 ppm 0.31 ppm

0.88 ppm

There have been no animal studies using radiolabeled PCNB. This appears to be a data gap.

SUMMARY OF THE REBUTTABLE PRESUMPTION -- ONCOGENICITY

40 CFR 162.11 (a) (3) (ii) (A) provides that a "rebuttable presumption shall arise if a pesticide's ingredient(s). . .(i)nduces oncogenic effects in experimental mammalian species or in man as a result of oral, inhalation, or dermal exposure. . . ." Section 162.3(bb) defines the term oncogenic as "the property of a substance or a mixture of substances to produce or induce benign or malignant tumor formation in living animals."

Several studies have been examined by the Environmental Protection Agency which present evidence that PCNB meets the above criterion.(22) Briefly, these findings:

1. A significant increase in hepatic carcinomas in male mice exposed to 1000 to 3000 ppm PCNB in the diet ($p<0.021$).

2. A significant increase in fibrosarcomas of the skin in female mice at 1200 ppm in the diet ($p<0.001$).

3. A significant increase in hepatomas in male mice fed 1206 ppm in the diet ($p<0.011$).

4. A significant increase in skin papillomas in mice receiving PCNB as an initiating agent followed by croton oil applications (males, $p<0.0225$; males and females and females combined, $p<0.011$).

5. A higher occurrence of malignant lymphoreticular tumors in male rats exposed to 1200 ppm in the diet ($p<0.0548$).

Following are ~~descriptions~~ summaries of the tests which resulted in these conclusions.

A. Hazleton Carcinogenesis Bioassay of PCNB

A carcinogenesis bioassay of PCNB was started in 1972 at Hazleton Laboratories, Inc. on behalf of the National Cancer Institute. The experiments used Osborne-Mendel rats (Supplier: BmI) and B6C3F1 mice (Supplier: Charles River Laboratories).

These animals were fed a mixture of corn oil and PCNB ad libitum at two dose levels, with 50 males and 50 females of each species in each group. Control groups for each species consisted of 20 animals of each sex.

The composition of the PCNB has been reported by the supplier as ~~(Olin Corporation, 1976).~~ follows:

	weight (%)
Pentachloronitrobenzene	98.1-98.2
Pentachlorobenzene	0.11-0.16

Chloranil	0.13-0.15
2,3,4,5-Tetrachloro-nitrobenzene	0.22-0.29
Hexachlorobenzene	1.0
High Boiler (unknown)	0.30-0.22

Male rats in the low dose group received 7,500 to 5,000 pp,. and 15,000 to 10,000 ppm PCNB in the high dose group. These doses were decreased to the second dosage rate after 14 weeks and continued until feeding was completed at 78 weeks. Low dose females were fed 11,000 ppm for 14 weeks; this was decreased to 7,250 ppm PCNB for the remainder of the experiment. High dose females received 22,000 ppm for 14 weeks and 14,500 ppm for the remaining feeding period. All animals were sacrificed after 111-113 weeks.

Mice were fed PCNB for 78 weeks. Low dose males were fed increasing doses of 1,075 ppm to 3,000 ppm, and high dose males received 2,150 to 6,000 ppm. Low dose females were fed 2,320 to 4,500 ppm and the high dose groups received 4,640 to 9,000 ppm. Surviving animals were sacrificed 91 to 93 weeks after the start of feeding.

The results obtained from rats showed a higher incidence of carcinomas in low dose PCNB-treated males and females. Female rats fed the low dose also had increases in statistically significant ($p<0.05$).

Carcinomas of the liver increased in low dose male mice, with eight of eighteen mice (44%) in that group, compared to two of twenty control male mice, developing carcinomas. This is significant at p 0.021, ~~(Alber, 1977)~~

B. Central Institute for Nutrition and Food Research -- Mouse Study

At the request of Farbwerke Hoechst AG (Frankfurt, W. Germany), the Central Institute for Nutrition and Food Research conducted a mouse carcinogenesis bioassay of PCNB. ~~(Van der Heijden and Til 1974)~~. According to the report, the technical grade sample contained:

	weight (%)
Pentachloronitrobenzene	98.2-98.3
Hexachlorobenzene	2.7
2,3,4,5-tetrachloronitrobenzene	1.1
2,3,5,6,-tetrachloronitrobenzene and 2,3,4,6-tetrachloronitrobenzene	0.64
Chloranil	<0.5

Diet pellets were administered ad libitum to SPF (Swiss random bred) males and females in 0,100, 400, and 1200 ppm dose groups for 80 weeks.

Gross necropsies were conducted. Tissues and tissues with gross abnormalities, three sections of the liver and each lung lobe were histologically prepared and examined. The gross examination showed skin abscesses and subcutaneous masses in females that had ingested 1200 ppm PCNB. From tissue specimens, they were identified as fibromas and fibrosarcomas. 12 of 91 females at this dose level, compared to none of the 90 control females, had these tumors at $p<0.001$. ~~(Albert 1977)~~.

C. Central Institute for Nutrition and Food Research -- Rat Study

In September, 1971 the Institute began a carcinogenesis test for PCNB on rats at the behest of Farbwerke Hoechst A. G ~~(Anonymous undated)~~. The technical material was the same as that used in the mouse study.

At the request of [illegible]

the [illegible] Institute for Nutrition [illegible] Food Research [illegible]

carcinogenesis bioassay of PCNB [illegible]

[illegible] to the report [illegible]

[illegible]

Pentachloronitrobenzene

Hexa[illegible]

2,3,4,5-tetrachloronitro

benz[illegible]

2,3,5,6-tetrachloronitro-

benzene and 2,3,4,6-tetra-

chloronitrobenzene

Chloranil

[illegible] were administered [illegible]

[illegible]es and females in [illegible] and 1200 ppm dose groups for [illegible] weeks.

Gross necropsies were conducted, [illegible] and tissues with gro[illegible]

[illegible]lities, three sections of the liver and each lung lobe were [illegible]

[illegible]cally prepared and examined. The gross examination showed [illegible]

[illegible] and subcutaneous masses in females that had ingested 1200 ppm [illegible]

From tissue specimens, they were identified as fibro[illegible]

[illegible] 12 of 91 females at this dose level, compared to none of the

[illegible] females, had these tumors [illegible] 0.001[illegible]

Males and females, 50 per dose group, were fed a diet of 0, 100, 400 and 1200 ppm for 104 weeks.

Complete gross necropsies were conducted to provide tissues for histological fixing and scrutiny. Tissue examinations were detailed for 20 males and females from the control and 1200 ppm groups, but were limited to the liver for all other animals and to grossly visible tumors or lesions suspected of being tumors.

26 of 47 (55%) males ingesting 100 ppm had significantly more lymphoreticular tumors of the lung ($p<0.0548$). Most of these tumors were found in treated males and 8 of 44 tumors were seen in untreated males (Albert 1977).

D. Innes Mouse Study

A tumorigenicity screening study on PCNB was conducted by Bionetics Research Laboratories, Inc. from 1966-1967 for the National Cancer Institute. ~~(Innes et al. 1969).~~ While the purity of the sample was not reported, it is suspected that it contained about 88% PCNB and 11% hexachlorobenzene. ~~(U.S.E.P.A. 1976b).~~

Strain X and Strain Y mice, (C57BL-6 x C3H/Anf)F1 and (C57B1/6 x AKR)F1, respectively, were administered 464 mg/kg PCNB (maximum tolerated dose) by stomach tube at seven to 28 days of age and orally in the diet ad libitum at 1,206 ppm up to necropsy at 78 weeks. There were 18 males and 18 females of each species in the control and treated groups.

Mice were grossly examined post mortem externally and in the thoracic and abdominal cavities. Tissues of major organs and of grossly visible lesions were reviewed microscopically. The cranium and thyroid glands were not dissected.

A significantly elevated incidence of liver tumors was found in

[illegible] and females, 50 per dose group were fed a diet [illegible]

[illegible] 1200 ppm for 101 weeks.

Complete gross necropsies were conducted [illegible] tissue

histological fixing and sectioning [illegible]

[illegible] males and females from the [illegible] and 1200 [illegible]

to the liver for all [illegible] animals and [illegible]

[illegible] suspected of being tumors.

24 of 47 (55%) males ingesting 100 ppm had [illegible]

[illegible] tumors [illegible] (p<0.048). [illegible]

in treated males and [illegible]

(Albert 1977).

D. [illegible] House Study

A [illegible] screening study [illegible] by Bio

s Research Laboratories, Inc. [illegible] National Cancer

Institute. [illegible] While the purity [illegible] the sample [illegible]

reported, it is suspected that [illegible]

[illegible]

Strain X and Strain Y mice, [illegible]

[illegible], respectively, were administered [illegible]

[illegible] by stomach tube at seven [illegible] days of age and daily [illegible]

[illegible] at 1,201 ppm up to [illegible] 78 weeks. [illegible]

[illegible] of each species in the control and treated groups

[illegible] examined grossly and [illegible]

[illegible] cavities. Tissues of major organs and of grossly

[illegible]

the Strain Y males ingesting PCNB. 10 of 17 (59%) treated males compared to 1 of 17 (6%) of control males had hoptomas at $p<0.0024$, ~~(Albert 1977).~~

E. Tumor Initiating Study in Mice

The University of Birmingham Cancer Research Laboratories in Birmingham, England has conducted a study on the tumor initiatory activity of technical PCNB. ~~(Searle 1966).~~ The purity of the compound was not reported.

Treated and untreated groups of albino mice (backgrouns unspecified), 6-8 weeks old, were assigned 10 males and 10 females each. The backs of mice to be treated were shaven and 0.3% PCNB dissolved in 0.2 ml acetone was applied twice weekly for 12 weeks. These mice then received applications of 0.25% croton oil on the same skin area for another 20 weeks. Mice were killed 20 weeks after the last croton oil treatment.

Total number of tumors and the numbers of mice bearing visible skin tumors were recorded weekly during croton oil treatment, and biweekly thereafter. Papillomas less than 1 mm in diameter or persisting less than three weeks were not counted.

Mice from treated and untreated groups began to develop papillomas after 508 weeks of croton oil treatment. Papillomas increased in number until 5-10 weeks after cessation of applications, when some papillomas regressed. Seven treated males had tumors as compared to only one in the control group, significant at $p<0.225$. ~~(Albert 1977).~~

Also, 14 of 20 treated males and females (combined), compared to 5 of 20 untreated males and females (combined), had papillomas, which is significant at $p<0.0225$.

[illegible] males tagged in [illegible], 10 of [illegible] treated males [illegible] 1 of 17 (6%) of control males [illegible]

3. [illegible] of [illegible]

The University of [illegible] [illegible]

[illegible]

[illegible]

[illegible] of mice to be treated [illegible]

[illegible]

[illegible] were killed [illegible]

Total number of [illegible] of mice [illegible] were recorded [illegible] thereafter. [illegible] less than 1 [illegible] diameter or persisting [illegible] three weeks were not counted.

[illegible] treated and untreated groups began to develop papillo[illegible] after 308 weeks of croton oil treatment. Papillomas [illegible] 5-10 weeks after cessation of [illegible] regressed. Seven treated mice had [illegible] control group [illegible] significance [illegible]

[illegible] treated mice [illegible] and [illegible]

Risks Related to Exposure associated with Registered Uses

~~Exposure and hazards associated with registered uses~~--The plant disease-producing organisms controlled by PCNB are nearly all soil-borne. In control measures PCNB is applied to seeds, vegetative parts used as seed (or propagative material) or to the soil. Soil application is made either as in-furrow, broadcast or spray treatments. In the former, the PCNB is covered by the planting equipment and in the latter two is disked in the soil. Thus no matter how PCNB is used, it is covered by or worked into the soil thus reducing exposure and drift so that they are virtually non-existent. Most applications are made only once a growing season or once a crop, thus minimizing the amounts used.

PCNB is available at 10%, 20%, 40% and 80% dusts, a 75% wettable powder, and emulsifiable concentrate and a 10% granular form.

Seed treatments are generally done by commercial processors using principally the Terra-Coat formulations of PCNB which dry to a hard finish on the seed and do not dust off during further handling. The only potential exposure occurs when workers are plumbing the source supply to the treating equipment. Some seeds are treated by a slurry method. Potential exposure in this method occurs during the mixing of the slurry and the bagging of treated seed. Once treated, little of the fungicide comes off the seed. The only other potential exposure is during the limited time the treated seed is poured into the hopper boxes on planting equipment. A third form of seed treatment is done by pouring the chemical into hopper boxes in layers with the seed. Worker exposure is limited to the opening of the container and measuring the PCNB into the hopper box.

For in-furrow treatments, PCNB is used principally as a granular material. Exposure is limited to opening the bag and pouring into the

Risk Related to Exposure Associated With Registered Uses

[illegible] The plant [illegible]-producing organisms controlled by PCNB are nearly all soil [illegible] control measures. PCNB is applied to seeds, vegetative parts [illegible] (or propagative material) or to the soil. Soil application is most [illegible] as in-furrow, broadcast or spray treatments. In the former, the [illegible] is covered by the planting equipment and in the latter two is mixed [illegible] the soil. Thus no matter how PCNB is used, it is covered or mixed into the soil thus reducing exposure [illegible] non existent. Most applications are but only once a growing season [illegible] on a crop, thus minimizing the amounts used.

PCNB is available as 10%, 20%, 40% and 80% dusts, a 75% wettable [illegible], emulsifiable concentrate and [illegible] granular form.

[illegible] treatments are generally done by commercial processors [illegible] principally the Terra-Coat formulations of PCNB which dry on [illegible] of the seed and do not dust off during further handling. The only [illegible] exposure occurs when workers are planting the seed or emptying [illegible] planting equipment. Some seeds are treated by a slurry method.

Exposure in this method occurs during the mixing of the slurry [illegible] the bagging of treated seed. When treated, little of the [illegible] off the seed. The only other potential exposure is during the [illegible] time the treated seed is poured into the hopper boxes on [illegible]. A third form of seed treatment is done by pouring the chem[illegible]

applicator. Granular formulations have little or no dust and therefore are very safe. In-furrow treatments also may be made with a liquid formulation. Exposure is limited to opening the can and mixing the concentrate with water. With all in-furrow treatments, the material is covered immediately by the planting device.

Broadcast treatments may be made using granular, liquid or wettable powder formulations. Exposure is limited to filling the spreading equipment. After application, the material is disked into the soil.

The use of PCNB is relatively safe for the following reasons:

1. It is rarely applied more than once for each crop.
2. It is used only a short period of the growing season, i.e., usually at or just before seeding or planting.
3. Workers handling it are exposed only for brief periods of time, i.e., opening and pouring the material from containers in which packaged.
4. Very few individuals are involved in the handling of the material.
5. Small quantities of PCNB are used. For example, in the treatment of cottonseed, only .2 to .3 pounds active PCNB are used per acre. In-furrow or band treatments use only 1 to 5 pounds active PCNB per acre. With a few minor crops the rate may go as high as 30 to 60 pounds active per acre.
6. PCNB is applied or mixed into only the top 2 to 6" of soil.
7. PCNB has a short life span in the soil (half life of 6 weeks at 75-80°F).
8. The actual application of PCNB is either on seed or directly into soil so there is little danger of the material drifting.

9. After application, the PCNB is covered or disked into the soil so it is not exposed.

10. PCNB is practically insoluble in water, therefore it stands little chance of contaminating water systems.

PCNB

Importance of ~~the pesticide~~ to agriculture

A. Major uses

1). Cotton

The largest use of PCNB is ~~in~~ the control of seedling disease of cotton. It is estimated (Minton 1978) that 520,000 - 540,000 pounds of active ingredient are used in the cotton belt as a seed treatment, resulting in enough treated seed to plant 6 million acres of cotton. In addition, 1 million pounds of active ingredient are used as an in-furrow treatment to treat another 1 million acres.

The primary organisms involved in the seedling diseases of cotton include Rhizoctonia solani, Pythium sp., Sclerotium rolfsii, Thielaviopsis basicola, Colletotrichum gossypii, and Meloidogyne incognita (~~Anonymous; Bird, 1974; Bollenbacher and Fulton, 1959; Fulton and Bollenbacher, 1959; Pinckard and Ivey, 1971; and Presley and Bird, 1960~~ 3, 11, 12, 24, 51, 52). Of these, pre-emergence killing was much more prevalent with Rhizoctonia solani and Pythium ultimum than with other fungi (~~Fulton and Bollenbacher, 1959~~ 24). In the same studies, it was pointed out that over a four-year period, Rhizoctonia solani occurred in 42% of the seedlings cultured; whereas, Fusarium (3 different species) were found in 49% of the seedlings.

In regard to the fungi involved in the seedling diseases of cotton, PCNB is effective in controlling Rhizotocnia solani and Sclerotium rolfsii. Inasmuch as no fungicide is available which is effective against all of the primary organisms involved in the seedling diseases of cotton (~~Bird, Ranney and Watkins, 1957; Bird and Raheem, 1967~~ 9, 10), and inasmuch as Rhizoctonia solani is the most important fungus of those attacking cotton seedlings, PCNB is the most widely used fungicide but it is mixed with other fungicides when used on cotton. Because so many organisms

are involved in the seedling diseases of cotton, it is difficult to estimate the losses due to the various disease-producing agents. However, the annual reduction in lint yield from seedling diseases from 1968 through 1977 was 2.9% or 319,982 bales (~~Crawford 1968-1978~~ 16). At $324 per bale, the annual loss was $103,674,168. These losses occur even though fungicides were used. It is estimated that without fungicides, the losses would have exceeded 20% or $714,994,262. The losses would have been larger had the reduced seed and lint qualities, root damage resulting in delayed maturity and costs of replanting been included.

In California, it is estimated that about 1 1/2 million acres of cotton were grown last year and that of this amount 20% of the seed was treated with PCNB and 10% of the acreage was treated with PCNB as an in-furrow treatment (~~R. Garber personal communication~~ 25).

Disease control in cotton results from either seed treatment or soil treatment at the time of planting, ~~(Minton 1978)~~. Thus the PCNB is used only at one time during the growing season. With either type of application, it is put into the soil and covered, thus exposing none to the atmosphere. In cotton, extremely small amounts of PCNB are used. When seeds are treated, approximately 1/2 ounce of PCNB is used per acre. When used as an in-furrow treatment only 1 pound is used per acre. Contact by handlers is limited to loading hopper boxes and/or treated seed.

2). Peanuts

The second most important use of PCNB is in the production of peanuts, most of which are grown in the southeastern states. Southern stem rot, resulting from infection by Sclerotium rolfsii, is the most serious disease of peanuts. Of the 1.5 million acres used for peanuts in the U.S., it is estimated that 20-30% is infested with this fungus. How-

Most PCNB on peanuts was used in Georgia followed in order by Oklahoma, Texas, Alabama, North Carolina, Virginia, South Carolina and Florida.

ever, it is a potential problem on the entire acreage. In 1977. PCNB was used on 144,000 acres (9.6% of the total peanut acreage) at the rate of 10 pounds active ingredient per acre resulting in a total useage of 1.44 million pounds.

Most PCNB on peanuts was used in Georgia followed in order by Oklahoma, Texas, Alabama, North Carolina, Virginia, South Carolina and Florida. It is estimated that the loss due to this disease in 1977 was $71,927,900 but if PCNB had not been available, the losses would have been $109,777,000, thus saving the peanut growers $27,850,000. Had it been used on the remaining infested acreage, the savings would have been at least $50,000,000 more than they were (Thompson, 1978).

In peanuts, the fungus may produce root rot, pod and peg rot or stem rot, the latter of which is the most important (~~Garren and Jackson 1973~~ 28). It occurs late in the season, usually during the last 45 days. Because of this, PCNB is applied in a 12 inch band over the foliage at pegging time (40-60 days after planting). Usually a single application is made. ~~(Thompson 1978).~~ The wettable powder, dust and granules are registered but 95% of the total amount applied on peanuts is the 10% granule. PCNB also is registered as a pre-plant and planting time treatment.

Because PCNB on peanuts is used as a granular and as a single application, the exposure hazards are minimal. No mixing is required, there is practically no danger of drift during application and the granular material, when applied, falls to the soil. Workers do not move through the field on foot, therefore there is little chance of exposure. Because the granular form is used mostly, exposure is estimated to be one minute per acre.

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Specialty

B. ~~Minor~~ Crops

The amount of PCNB used on specialty ~~minor~~ crops amounts to about 4% of the total. This is used principally on vegetables, ornamentals and turf, small grains and sugar beets.

1). Vegetables

In vegetables, disease-producing organisms which are controlled by PCNB include Rhizoctonia solani, Sclerotium rolfii, Sclerotium cepivorium, Plasmodiophora brassicae and Streptomyces scabies.

Of these, Rhizoctonia solani occurs as a problem on members of the Cruciferae (broccoli, Brussels sprouts, cabbage, cauliflower, etc.) beans, peas and potatoes but it is most severe on crucifers and potatoes. In crucifers, the fungus may cause damping off of seedlings or infect mature plants causing a disease called wire stem. PCNB is needed for control in California and New York for seedbeds. On grown plants, it is used on about 1000 acres in Florida and 2000 acres in Georgia. In Michigan, about 8000 acres are treated for the control of Rhizoctonia and Plasmodiophora brassicae (Stevenson 1978).

Plasmodiophora brassicae is the causal agent of club root disease of crucifers. In New York, yield losses on cabbage and cauliflower have been reported as high as 40% and PCNB is now used on 13,500 acres. In some areas of Michigan, the cabbage and cauliflower crops in 1975 were a total loss. ~~(Stevenson 1978).~~ In California 500 acres are infested with the fungus. It is estimated that only 30% of the crop would be harvested if the fungus were not controlled by PCNB (~~Sciaroni personal communication~~ 54).

To control Rhizoctonia or Plasmodiophora, PCNB is added either as a transplant drench or as a preplant treatment as a row or broadcast

The amount of PCNB used [illegible]

[illegible]. This is used principally on vegetables, [illegible]

[illegible] grains and sugar [illegible]

1). Vegetables

In vegetables diseases [illegible]

include *Rhizoctonia solani*, *Sclerotium* [illegible]

[illegible], *Plasmodiophora brassicae* [illegible]

Of these *Rhizoctonia solani* [illegible]

Cruciferae (broccoli, Brussels sprouts, [illegible] cauliflower [illegible]

[illegible] peas and potatoes [illegible]

[illegible]cifers, the fungus [illegible]

plants causing a disease [illegible]

[illegible]trol in California and New York for [illegible]

[illegible] on about 1000 acres in Florida and [illegible]

[illegible], about 3000 acres are treated for the control of [illegible]

[illegible]diophora brassicae (Stevenson 1978).

Plasmodiophora brassicae is the causal agent [illegible]

[illegible] crucifers. In New York, yield losses [illegible] cabbage and [illegible]

[illegible] reported as high as 40% and PCNB [illegible]

[illegible] areas of Michigan, the cabbage and cauliflower [illegible]

[illegible]ical loss (Stevenson [illegible]). In California 500 acres are [illegible]

It is estimated that only 30% of the crop would [illegible]

[illegible] not controlled by PCNB [illegible]

PCNB is [illegible]

[illegible]

application. Formulations used include the 75% w.p., 10% dust or 10% granules. All applications are applied only once per crop and in all, the PCNB is covered in transplanting or disked into the soil. ~~(Stevenson 1978).~~

Rhizoctonia also occurs on beans causing damping off and hypocotyl rot. Although PCNB is registered on beans, very little is used. In New York, less than 2000 acres were treated whereas in Nebraska, less than 500 acres were treated (Kraft 1978).

Potatoes are also infected by Rhizoctonia resulting in either cankers on the stems and stolons or a killing of the young shoots. The fungus produces resting structures on the outsides of the tubers which do not damage the tubers but may be a source of inoculum to infect the new growth if such tubers are used as a source of seed pieces. It is estimated that a 10% yield loss occurs in untreated fields. ~~According to Weinhold (personal communication)~~ PCNB at low concentrations is effective in inhibiting Rhizoctonia and when used can reduce severity of stem and stolon cankers by 50-60%.(62) If controlled, the values of the U.S. potato crop would be increased by about $15 million.

Common scab, resulting from infection by the bacterium Streptomyces scabies reduces the quality of potato tubers. In Idaho, it is estimated that revenue loss is at least 5% due to this disease-producing agent. PCNB is the most dependable control and where scab is severe, a PCNB treatment may mean the difference between staying in or not staying in business. ~~(Kraft 1978)~~

PCNB is used as a soil treatment prior to or at the time of planting on potatoes. Only a single application is made and either way the material is incorporated into the soil. ~~(Kraft 1978)~~

Sclerotium rolfsii is severe in the southern states,

particularly on tomato and pepper crops where it causes losses as high as 20%. This fungus attacks plants at the soil line causing death of infected plants. In Georgia, it is estimated that 2000 acres of peppers and 100 acres of tomatoes are treated to control this fungus. Inasmuch as these crops are sometimes rotated with peanuts, it makes control that much more important. ~~(Stevenson 1978)~~. PCNB may be added to the transplant water or as a trench spray at planting time or it may be added as a trench dust prior to transplanting. ~~(Stevenson 1978)~~. In any of the methods of application, the PCNB is covered by soil and is not left exposed to the air.

Sclerotium cepivorum is a serious fungus on garlic in California where 9,100 acres were produced in 1976 (with a value of approximately $12 million) It is estimated that the fungus occurs on 10-20% of the acreage and causes annual losses of 5-10% (Stevenson 1978). Control with PCNB is essential. The material is applied as an in-furrow treatment, as a row treatment or as a clove treatment. In all of the treatments, the PCNB is covered by soil following planting thus reducing exposure. ~~(Stevenson 1978)~~

2). Ornamentals

a). ~~According to the EPA (Summings 1976)~~, PCNB is labelled (19) for use on ornamental plants as follows:

i). to control Rhizoctonia solani on African violets, begonia, carnation, chrysanthemum, dichondra (included in this report with turf grasses), Easter lily, poinsettia, snapdragon, and sweet peas. Actual amounts used were difficult to determine. In regard to carnations, in California, there are approximately 500 acres of carnations (~~Hasek personal communication~~) (32). Approximately 1/2 of the acreage is replanted

each year and it is estimated that at least 1/2 of this is treated with PCNB to control Rhizoctonia. which infects young. rooted cuttings after planting. (~~Farnham Personal communication~~ 23 1). The material is applied at the rate of 1# of the 75% wettable powder per 1000 sq. ft. as a drench or dusted onto the soil and then rototilled in the top 3 to 4 inches. Excellent control is obtained (~~Sciaroni and Raabe 1955~~ 55 1).

Chrysanthemums (standards, pompoms and pots) accounted for sales of 116 million dollars in 1976 (~~Crop Reporting Board 1977~~ 17 1). Of the main soil borne disease-producing organisms, Rhizoctonia, Sclerotinia and Pythium are important. According to Horst and Nelson (~~1975~~ 37 1) in their publication on diseases of chrysanthemum, PCNB is recommended for control of Rhizoctonia and is listed as one of several fungicides for control of Sclerotinia.

~~According to Knauss (personal communication)~~ Rhizoctonia is one of the more serious pathogens of foliage plants in the $111 million industry in Florida (17) and ~~he estimates that~~ at a minimum (1) causes a 5% loss (42) 1 (or more than $5 million dollars per year). Without PCNB, the loss would be much greater.

Rhizoctonia is important on lilies and poinsettias but because it occurs with other fungi, it will be discussed under labels with mixtures.

ii). to control Sclerotinia sclerotiorum on calendula, larkspur, snapdragon, and sweet peas and also to control Sclerotinia bulborum on hyacinth, iris, narcissus and tulip.

In regard to S. sclerotiorum, little information on the listed crops is available. ~~According to the Crop Reporting Board (1977) the wholesale value of plants in Florida in 1976 was $111 million~~. Recently

and [illegible] as [illegible]

to control Rhizoctonia [illegible]

[illegible]ting. [illegible]

rate of [illegible] the [illegible]

[illegible] dusted [illegible]

[illegible] effective control is [illegible]

[illegible]

Some [illegible]

[illegible]tion [illegible] dis[illegible] [illegible]

Rhizoctonia and [illegible]

Sclerotinia

[illegible]

be [illegible] serious with [illegible]

Rhizoctonia is important [illegible] lilies [illegible]

with other [illegible] it will [illegible] discussed [illegible]

to control Sclerotinia [illegible]

[illegible] and sweet peas and als to control [illegible]

n b. iris, narcissus and tulip.

In regard to S. [illegible], little information [illegible]

however, ~~J.F. Knauss, (personal communication) stated that PCNB is~~ PCNB was reported to be one of the fungicides which gives effective control of this fungus on foliage plants. (42)

Good control of S. bulborum on hyacinth, iris and tulip with PCNB has been reported (~~Gould and Russell 1965~~ 29).

iii). to control Sclerotium rolfsii on hyacinth, iris, bulbous iris, narcissus and tulips. The amount used on these crops could not be determined. ~~Knauss (personal communication) estimates~~ The losses in ornamental foliage plants from this fungus are estimated to be between 3-5% (42). ~~and has found~~ PCNB ~~is~~ gives effective control on Schefflera, Peperomia (~~Alfori and Knauss 1970, Alfori and Knauss 1972~~ 1,2) and many other foliage plants (~~Knauss, personal communication~~ 42). Without it, ~~Knauss said~~ the foliage plant industry would be in serious trouble.

iv). to control Sclerotinia camelliae on camellias (flower blight) and Ovulinia azaleae on azaleas (flower blight). In trials to control camellia flower blight (~~Ansalone and Plakidas 1958~~ 4), it was determined PCNB gave best control of the materials tested. Shurtleff (~~1966~~ 56) included PCNB in the control measures for azalea petal blight.

b). ~~According to Cummings (1976)~~ PCNB is labelled in mixtures with other fungicides for the control of damping off and/or root and stem rots where complexes of various pathogens occur in African violets, begonia, calendula, carnation, chrysanthemum, dahlias, flowering plants, iris, larkspur, lily (Croft Easter lily), nursery plants, ornamental shrubs, poinsettia, snapdragon, sweet peas and tuberous begonia. (19) Although large quantities of PCNB are not used, the use is essential whenever Rhizoctonia is present in the disease complex.

In the production of poinsettias as a pot plant, the

[illegible]

[illegible] fungicides [illegible] given [illegible]

[illegible] control [illegible]

[illegible]

[illegible] control [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

control of [illegible]

[illegible] on [illegible]

[illegible] ([illegible]), [illegible]

control of the materials tested. Chart [illegible]

control measures for azalea petal blight.

b) [illegible]

es with other fungicides for the control of [illegible]

[illegible] complexes of various [illegible]

[illegible] calendula, carnation, chrysanthemum, [illegible]

[illegible], larkspur, lily (Croft Easter Lily), [illegible]

[illegible]

[illegible] the use is essential.

[illegible] complex

[illegible]

wholesale value of the crop in the United States in 1976 was $35 1/2 million (~~Crop Reporting Board 1977~~ 17). In the currently available literature on the production of this plant (~~Ball 1972~~; ~~Bing et al. 1974~~; ~~Ecke 1976~~ 6, 8, 21), all recommend either PCNB as a drench after planting if Rhizoctonia alone is present or PCNB + Dexon as a drench after planting if Rhizoctonia and Pythium are present.

Potted lilies are an important crop and it is estimated that 7 million were sold in 1976 with an estimated wholesale value of 14 million dollars (17). Ball (~~1972~~ 6) recommendations for potted lily production include:

1. drenching the soil with Dexon-PCNB at first watering;
2. add PCNB-captan to the potting soil and;
3. immerse the bulbs for 5-15 minutes before potting in water containing PCNB and ferbam.

Bing et al. (~~1974~~ 8) recommended drenching newly potted bulbs with a mixture of PCNB-Dexon.

~~According to the Crop Reporting Board (1977),~~ the wholesale value of flowering bedding plants in 1976 was $61.4 million (17). If vegetable bedding plants are added to this, it raises the total to $108.4 million. The amount of PCNB used is unknown. However, Rhizoctonia is part of the damping off complex, which if uncontrolled, usually results in the complete loss of all plants growing in any container (flats, pony packs, etc.) where it occurs. ~~According to Masterlarz (1976)~~ Prevention of Rhizoctonia in bedding plants may be done either with benomyl or PCNB (47).

c). In summary, although a large quantity of PCNB is not used in controlling disease-producing organisms on ornamental plants, it appears that there is a critical need for the chemical in that:

[illegible] value of the crop in the United States is [illegible]

lion [illegible]) In the currently available literature

production of this plant [illegible]

recommend either [illegible] drench after planting if [illegible]

present or PCNB + Dexon as drench after planting if [illegible]

Pythium are present.

Potted lilies are an important [illegible]

7 million were sold in 1976 [illegible]

dollars. Bald [illegible] recommendations for potting [illegible]

1. drenching the soil with Terra PCNB [illegible]
2. add PCNB-compost to the potting soil or
3. immerse the bulbs for 15 minutes [illegible]
   containing PCNB and [illegible].

[illegible] et al. (1968) recommend drenching newly potted bulbs [illegible]

[illegible] [illegible] [illegible] [illegible]

[illegible] of flowering bedding plants in 1976 was $81.[illegible] million [illegible]

bedding plants are added to that it raises the total to $118.[illegible]

[illegible]. The amount of PCNB used is unknown. However, [illegible]

of the damping off complex, which is uncontrolled, [illegible]

[illegible] a loss of all [illegible] growing [illegible] containers [illegible]

[illegible]

bedding plants [illegible] with [illegible]

summary, [illegible] PCNB [illegible]

[illegible]

i). The California carnation industry uses it as a pre-plant treatment before setting out rooted cuttings.

ii). The recommendations in growers manuals for handling poinsettias include a PCNB-Dexon drench at planting time.

iii). The recommendations in growers manuals for producing Easter lilies include either a PCNB-Dexon drench or a drench plus a PCNB-captan soil treatment and a PCNB-Fermate bulb dip.

iv). The manual on bedding plant production recommends PCNB to control Rhizoctonia.

v). It is effective in control of Sclerotinia bulborum on hyacinth, iris, and tulip.

vi). It is the only effective material for controlling the azalea flower blight fungus and the camellia flower blight fungus.

vii). It is important in the control of Sclerotium rolsii, Sclerotinia sclerotiorum and Rhizoctonia in the production of foliage plants.

3). Turfgrasses

PCNB is labelled for the control of more different kinds of plant pathogenic fungi on turf grasses than any other single group of plants. It is labelled for Rhizoctonia (brownpatch), Sclerotinia (dollar spot), Typhula (gray snow mold), Fusarium (pink snow mold), Puccinia (rusts), Ustilago (stripe smut) and leaf spot (causal organism not identified on bluegrass, centipede grass, fescue, ryegrass and St. Augustine grass. In addition, it is labelled along for brownpatch on bentgrass, Bermuda grass and dichrondra. It also is labelled with other fungicides for the control of various diseases including cottony blight, fading out, gray leaf spot, melting out and powdery mildew on some or all of the

grasses listed (and dichondra).

It is estimated that there are 10 million acres of turf associated with industrial sites, recreation areas, public facilities and sod farms. Golf courses alone account for 1 1/2 million acres. In 1975 the lawn and garden industry estimated that $1.1 billion was spent for chemicals. How much of this was PCNB could not be determined (Hoffman, et al.).

In the control of the various disease-producing fungi in turf with PCNB, generally only one application is made per growing season, though occasionally more than one application may be made.

4). Small grains

In the Pacific Northwest, PCNB is used as a seed treatment on winter wheat to control Ustilago (common bunt). Without control, it is estimated losses due to this fungus would be $4.5 million (Hoffman 1977). Excellent control with inoculated wheat seeds has been obtained (31), ~~by Hansing (1973)~~. Hoffman (~~1973, 1974~~ 35, 36) obtained almost 90-100% control using inoculated seeds in both infested and non-infested soil. PCNB also is used in controlling flagsmut of wheat (Ustilago) in Washington (~~Line 1973 and Line and Hewitt 1974~~ 45, 46).

PCNB is registered as a seed treatment on wheat and is used at the rate of .25 to .5 oz. per bushel. Seeding rate is about 1 bushel per acre meaning that extremely small quantities of PCNB are used.

In California, approximately 125,000 acres of barley, 90,000 acres of wheat and 25,000 acres of oats are grown. To control bunt of wheat and covered smuts of barley and oats, PCNB is used as a seed treatment material and it is estimated that at least half the seed planted each year is treated (~~Hall, personal communication~~ 30).

5). Sugar beets

To prevent damping off of sugar beets resulting from Rhizoctonia and Pythium sp., it is common practice to treat sugar beet seed with a mixture of PCNB-Dexon. Only 2 oz. of active PCNB are used per 100 # of seed (~~Hall, personal communication~~ 30 1), and only 2 to 3 pounds of seed are used per acre. It is estimated that in 1977, sugar beet acreage in the leading states was as follows: Minnesota, 260,000; California, 250,000; Idaho, 106,000; Colorado, 72,000; Nebraska, 67,000; and Washington, 62,000. (~~Hills, personal communication~~ 34 1).

PCNB

Importance of maintaining ~~the pesticide~~ uses in agriculture

The largest use of PCNB is on cotton for the control of Rhizoctonia solani, the most important organism of a complex of fungi involved in seedling diseases of that plant. In most years, about 77% of all PCNB is used either as a seed treatment or an in-furrow treatment on this crop. Even with seed treatment, losses are about $104 million but without seed treatment, losses would be $715 million. These losses are only those which are direct and do not include those which are indirect. Presently, PCNB is the cheapest and one of the more effective fungicides used in the production of this important crop. In cotton, PCNB is applied either as a seed treatment or as an in-furrow treatment at the time of planting. With seed treatment, approximately 1¼ ounces of active PCNB are used per acre. In-furrow treatment uses about one pound active PCNB per acre. In view of the extremely small amounts use, the very limited exposure of the workers (plumbing seed treatment equipment and loading hoppers with seed or the fungicide), the fact that the material is used only once in a growing season, the fact that the treated seed and the fungicide are covered by soil when used, the fact that PCNB is very insoluble and does not enter drainage or run-off water, and that it breaks down fairly rapidly in the soil plus the fact that it is very important in the production of a major crop, the benefits from the use of PCNB on cotton must be considered outstanding.

Another major use of PCNB is in the production of peanuts where PCNB is used to control the soil-borne Sclerotium rolfsii. Generally about 17% of the total PCNB is used on this crop though in 1977, because of a

The largest use [illegible] PCNB is on cotton [illegible] the most important organism of a complex [illegible] involved [illegible] diseases of that plant. In most years, [illegible] of all PCNB is used [illegible] seed treatment or [illegible] crop. Even with seed treatment, losses [illegible] out seed treatment, losses would be [illegible] which are direct and do not include [illegible] PCNB is the cheapest [illegible] in the production of this important crop. [illegible] either as a seed treatment or as an in-furrow treatment [illegible] of planting. With seed treatment, approximately [illegible] PCNB are used per acre. In furrow treatments [illegible] active PCNB per acre. In view of the extremely small amounts used, the very limited exposure of the workers [illegible] and loading hoppers with seed [illegible] that is used only once in a growing season, the fact that the [illegible] and the fungicide are covered by soil when used, the fact that PCNB [illegible] insoluble and does not enter drainage [illegible] break down fairly rapidly in the soil plus the fact that it is very important in the production of a major crop, the benefits from the use of PCNB on cotton must be considered outstanding.

[illegible]

very severe outbreak of S. rolfsii in peanuts, almost one half of the total PCNB used that year was used on this crop. Even then, it was used only on about 10% of the peanut acreage and it is estimated that 20-30% of the acreage is infested with this fungus. It is estimated that PCNB saved the peanut growers nearly $28 million in 1977 and that if the rest of the infested acreage had been treated, the savings would have been $50 million. In peanuts, PCNB is used principally to control stem rot which occurs late in the growing season. PCNB is applied in a 12 inch band as a granular material in a single application at pegging time. Although applied to the tops of the plants, the material falls to the soil. Exposure is limited to loading the hopper boxes and there is no travel through peanut fields by foot at this time of the growing season. The granular gorm also minimizes the exposure. PCNB is the cheapest and most effective material for controlling this important disease-producing agent of peanuts, exposure is extremely limited, only a single application is made using the granular form and therefore the benefits from the use of PCNB on peanuts are outstanding.

The specialty uses of PCNB amount to about 4% of the total. Though the amounts are not large, they are very important in the control of certain disease-producing agents. In the production of crucifer crops, control of Plasmodiophora brassicae, the causal agent of club root, is essential in soils infested with the fungus. Losses due to this fungus have been estimated at 40% on cabbage and cauliflower in New York, would be 70% on Brussels sprouts in California if not controlled and have been 100% in some areas of Michigan on cabbage and cauliflower. PCNB is used in either the transplant water or is disked into the soil prior to planting. A single application is made per growing season and the material is

severe outbreak [illegible] 3, 701 [illegible]

[illegible] PCNB used that year [illegible] this [illegible]

only on about 10% of the peanut [illegible]

the acreage [illegible] with this fungus [illegible]

caused the peanut grower [illegible] \$15 [illegible]

the interest acreage had been [illegible] the last [illegible]

\$50 million[1] in peanuts, PCNB [illegible]

which occurs late in the growth, so [illegible] PCNB is used

as a granular material [illegible]

only applied to the row [illegible]

soil. Exposure is limited [illegible]

travel through peanut fields [illegible]

granular form [illegible] minimize [illegible]

effective material for control [illegible]

age of peanuts, exposure is extremely limited [illegible]

which is made using the granular form [illegible]

use of PCNB on peanuts are outstanding.

The minor uses of PCNB amount to [illegible]

are not large, they are very important [illegible]

disease-producing agents. In the production [illegible]

Plasmodiophora brassicae, the causal agent [illegible]

is infested with the fungus. Losses due to this fungus has [illegible]

estimated at 40% on cabbage and cauliflower [illegible]

Brussels sprouts in California [illegible]

[illegible] cabbage and cauliflower. PCNB is used [illegible]

[illegible] water or [illegible] the soil prior to planting.

[illegible] made [illegible] growing season and the material is

covered by soil with either method of application.

PCNB is also used to control Rhizoctonia solani on a number of plants, including carnations, potatoes, foliage plants, chrysanthemums and crucifers. Losses of foliage plants would amount to 3-5% in Florida if not controlled. If controlled on potatoes, the savings would be $25 million. The losses on carnations are not known but half the acreage in California is treated with PCNB prior to planting. The leading manual on chrysanthemum production recommends PCNB for control of Rhizoctonia on that crop. In all of these crops, PCNB is added to the soil once before planting and then is worked into the soil thereby limiting exposure.

PCNB is also used to control Rhizoctonia solani in complexes where other disease-producing agents occur and therefore it is mixed with other fungicides. This is particularly true on poinsettias and Easter lilies. The leading manuals on the culture of these plants include PCNB in the standard recommendations for growing these plants. As with other crops, it is mixed in the soil or used as a bulb dip prior to planting.

A number of disease-producing organisms occur on various turf grasses which are controlled by PCNB. These include: Rhizoctonia, Sclerotinia, Typhula, Fusarium, Puccinia and Ustilago. A number of formulations are available for use on turf, including the granular. Most applications are made once a growing season.

In small grains, PCNB is used as a seed treatment for control of covered smuts. Very small amounts (.25 to .5 oz) per bushel (1 bushel to an acre) are used to give extremely high control on wheat, barley and oats. PCNB is as effective and far cheaper than other materials

being used.

Sugar beets are subject to seedling diseases resulting from Rhizoctonia and Pythium sp. It is a common practice to treat sugar beet seed with PCNB-Dexon. Only 2 oz active PCNB are used per 100# of seed and 2 to 3 pounds of seed are used per acre.

It is apparent that PCNB is a selective chemical controlling a limited number of fungi in the lower Basidiomycotina (Rhizoctonia, Sclerotium, Typhula, Ustilago and Puccinia) some fungi in the higher Ascomycotina (3 species of Sclerotinia and Ovulinia), one fungus in the Fungi Imperfecti (Fusarium), a fungus in the Mastigimycotina (Plasmodiophora brassicae) and a bacterium (Streptomyces scabies). Because of its rather limited effective range, the material will do little to upset the biological balance in soils when used in controlling plant disease organisms.

Conclusions and summary

On the basis of information presented here regarding PCNB, it can be concluded that:

1. PCNB is effective in controlling: major soil-borne fungi such as Rhizoctonia solani, Sclerotium rolfsii, Sclerotinia sclerotiorum, Plasmodiophora brassicae, Streptomyces scabies; Ustilago on small grains and Ustilago, Sclerotinia, Typhula Fusarium and Puccinia on turf grasses; Sclerotinia bulborum on hyacinth, iris and tulip; and Sclerotinia on camellia and Ovulinia on azalea.

2. PCNB is safe to use, being applied as a seed treatment, an in-furrow treatment or as a soil treatment. In practically all applications, PCNB is covered by soil allowing very little exposed.

3. PCNB is usually applied once in a growing season.

4. As a seed treatment or in-furrow treatment, very small quantities of PCNB are used per acre.

5. PCNB is not water soluble and does not enter run-off water on drainage water

6. The seed treatment formulation dries to an exceedingly hard surfacing on the seed.

7. The granular formations leave little or not dust.

8. PCNB has a short life in the soil (6 weeks at 75-80° F).

9. Exposure to PCNB is minimal and is restricted principally to the plumbing of seed treaters and the pouring of treated seed or the fungicide into hoppers.

10. PCNB is usually lower priced than similarly effective fungicides.

11. PCNB is a selective fungicide in regard to the fungi against which it is effective. The number of organisms is not large and therefore this material when used will upset the biological environment very little as compared to a broad spectrum fungicide.

Because PCNB is effective in controlling a number of important plant pathogens, because very little is used and when used, it is added to the soil and usually is covered, because there is little chance of it entering air or water systems, because there is very little exposure danger in application ~~because it is competitively priced and because the~~ ~~benefits, price~~ the benefits of PCNB are far greater than the risks and therefore registration of PCNB should be continued.

ii. PCNB is a selective fungicide in regard to the fungi against which it is effective. The number of organisms [illegible] and there[illegible] this material when used will upset the biological [illegible] very little [illegible] spectrum fungicide.

Because PCNB is effective in controlling a number [illegible] pathogens, because very little is used and when used, [illegible] to the soil and usually is covered, because there is little chance of [illegible] air or water systems, because there is very little exposure [illegible] application [illegible]

the benefits of PCNB are far greater than the risks and therefore registration of PCNB should be continued.

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**** PRODUCT SEARCH LISTING **** PAGE 1

09/21/77 FEDERALLY REGISTERED PRODUCTS CONTAINING PCNB

REGISTRANT *NAME AND ADDRESS*

* 000148 THOMPSON-HAYWARD CHEMICAL COMPANY
BOX 2383
KANSAS CITY KS 66110

********** PRODUCT NAME **********

**00764* DE-FESTER TERRACHLOR 10% GRANULES

**00780* DE-FESTER TERRACHLOR-CAPTAN NO 10-10

**01040* T-H 20% TERRACLOR DUST

**01062* T-H TERRACLOR 2 LB. EMULSIFIABLE CONCENTRATE

**01077* T-H 10% TERRACLOR DUST

REGISTRANT *NAME AND ADDRESS*

* 000239 CHEVRON CHEMICAL COMPANY
ORTHO DIVISION 940 HENSLEY WAY
RICHMOND CA 94801

********** PRODUCT NAME **********

**01522* ORTHO LAWN DISEASE CONTROL

**02073* ORTHOCIDE SOIL TREATER X-W

**02162* ORTHO PCNB 80 DUST CONCENTRATE

**02213* ORTHO SOIL TREATER 3 "X"

**02382* ORTHO ORTHOCIDE SOIL TREATER "X"

REGISTRANT *NAME AND ADDRESS*

* 000241 AMERICAN CYANAMID COMPANY
BOX 400
PRINCETON NJ 08540

********** PRODUCT NAME **********

**00146* THIRET 10% SYS. INSECT./TERRACLOR SUPER X SOIL FUNGI. DR

REGISTRANT *NAME AND ADDRESS*

* 000279 FMC CORP.
AGRICULTURAL CHEM DIV.
2000 MARKET STREET
PHILADELPHIA, PA. 19103

********** PRODUCT NAME **********

**01250* NIAGARA PCNB 40 DUST CODE: 30260

**02222* NIAGARA PCNB10 ZINEB 10 SOIL TREATER

**02354* NIAGARA LANSTAN 10 PCNB-5 GRANULAR SOIL FUNGICIDE

**02591* TERRACLOR 6.5 SUPER X 1.6 THIMET 6.5 GRANULAR CODE: 31964

**02938* TERRACLOR 6.5 THIMET 6.5 GRANULAR

**02967* TERRACLOR 5 ZINEB 2/5 THIMET 5 COATED GRANULES

**02975* CAPTAN TERRACHLOR 10-10

REGISTRANT *NAME AND ADDRESS*

* 000476 STAUFFER CHEMICAL COMPANY LABELING & REGISTRATION
DEPT 1200 SOUTH 47TH ST
RICHMOND, CA 94804

********** PRODUCT NAME **********

**01315* STAUFFER CAPTAN TERRACLOR 10-10 SEED PROTECTANT

**01437* TERRACLOR 10 DUST

**01500* CAPTAN-PCNB 10-10 DUST

**01739* TERRACLOR 10 G GRANULES

**01881* CAPTAN-PCNB 10-10 GRANULAR

**01928* CAPTAN TERRACLOR 30-30 WP SEED PROTECTANT

**01977* CAPTAN-TERRACLOR* 30-30 SEED PROTECTANT

REGISTRANT *NAME AND ADDRESS*

* 000524 MONSANTO COMPANY
AGRICULTURAL PRODUCTS
800 N. LINDBERGH BLVD.
ST. LOUIS, MO 63166

********** PRODUCT NAME **********

**00121* PCNB 80% DUST CONCENTRATE

**00122* PCNB TECHNICAL GRADE

REGISTRANT	*NAME AND ADDRESS*
* 000538	SCOTT O M & SONS COMPANY MARYSVILLE OH 43040

********** PRODUCT NAME **********

**00040* PROTURF FF 11

**00050* FUNGICIDE WITH FERTILIZER FOR BLUEGRASS LAWNS

**00055* SCOTTS FUNGICIDE WITH FERTILIZER FOR ST. AUGUSTINE GRASS LAWNS

**00078* LAWN DISEASE CONTROL

**00096* NEW LAWN DISEASE CONTROL

**00108* PROTURF NEW FF II

**00116* SCOTTS TURF BUILDER PLUS LAWN DISEASE PREVENTER

REGISTRANT	*NAME AND ADDRESS*
* 000550	VAN WATERS & ROGERS DIV OF UNIVAR 2256 JUNCTION AVENUE SAN JOSE, CA 95131

********** PRODUCT NAME **********

**00091* GUARDSMAN SEED GUARD

REGISTRANT	*NAME AND ADDRESS*
* 000554	AGSCO INC BOX 458 GRAND FORKS ND 58201

********** PRODUCT NAME **********

**00110* AGSCO PCNB-E.C.

REGISTRANT	*NAME AND ADDRESS*
* 000557	SWIFT AGRICULTURAL CHEMICAL CORP. 111 WEST JACKSON BOULEVARD CHICAGO, IL 60604

********** PRODUCT NAME **********

**01856* VIGORO BROWN PATCH CONTROL PLUS FERTILIZER

REGISTRANT *NAME AND ADDRESS*

* 000728 SOUTHLAND PEARSON & COMPANY
PO BOX 7151
MOBILE AL 36601

********** PRODUCT NAME **********

**00091* PEARSONS GREEN LAWN FUNGICIDE

REGISTRANT *NAME AND ADDRESS*

* 000802 LILLY CHAS H COMPANY MILLER RD DIV
7737 N.E. KILLINGSWORTH
PORTLAND, OR 97218

********** PRODUCT NAME **********

**00494* MILLER S TERRACHLOR 200 FUNGICIDE

REGISTRANT *NAME AND ADDRESS*

* 000869 GREEN LIGHT COMPANY
P.O. BOX 17985
SAN ANTONIO, TX 78217

********** PRODUCT NAME **********

**00037* GREEN LIGHT BULB STARTER & FOOD

REGISTRANT *NAME AND ADDRESS*

* 001023 TUCO PRODUCTS COMPANY
DIV UPJOHN CO 7171 PORTAGE RD
KALAMAZOO MI 49001

********** PRODUCT NAME **********

**00010* ACTI DIONE - RZ

REGISTRANT *NAME AND ADDRESS*

* 001202 PUREGRO COMPANY
1052 W 6TH ST
LOS ANGELES CA 90017

********** PRODUCT NAME **********

**00105* GAVICIDE THIMET PCNB 6.5-6.5

**00192* PUREGRO TERRACHLOR 20 DUST

**00193* PUREGRO TERRACHLOR 10 GRANULES

**00203* PUREGRO DI SYSTON PCNB 6.5-6.5

REGISTRANT	*NAME AND ADDRESS*
* 001258	OLIN CHEMICALS OLIN CORPORATION 120 LONG RIDGE ROAD STAMFORD, CT 06904

********** PRODUCT NAME **********

**00158* MATHIESON TERRACLOR 20% DUST

**00185* OLIN TERRACLOR 75% WETTABLE POWDER

**00279* TERRACLOR 2 LB EMULSIFIABLE SOIL FUNGICIDE

**00286* TERRACLOR 40% DUST SOIL FUNGICIDE

**00287* TERRACLOR 10% DUST-SOIL FUNGICIDE

**00407* MATHIESON BRAND TERRACLOR LANDPLASTER MIXTURE

**00466* MATHIESON TERRACAP 10-10-DUST

**00516* MATHIESON TERRACLOR 80% DUST CONCENTRATE

**00517* OLIN TERRACLOR TECHNICAL GRADE PCNB 99% SOIL FUNGICIDE

**00555* MATHIESON TERRACLOR 10% GRANULAR

**00584* MATHIESON GREENBACK LAWN FUNGICIDE

**00589* OLIN TURFCIDE EMULSIFIABLE TERRACLOR FUNGICIDE

**00740* OLIN TERRACLOR SUPER-X EMULSIFIABLE SOIL FUNGICIDE

**00758* TERRACLOR SUPER X GRANULAR 10-2.5 SOIL FUNGICIDE

**00759* OLIN TERRACLOR SUPER X DUST-SOIL FUNGICIDE

**00760* OLIN TERRACLOR SUPER X PRE MIX DUST SOIL FUNG TERRACLOR PLUS TERRAZOLE

**00765* TURFCIDE 10% GRANULAR SOIL FUNGICIDE

**00776* TERRACLOR SUP X SOIL FUNG WITH DI SYSTON SYSTEMIC INSECT GRANULAR

**00786* OLIN TERRA-COAT COTTON SEED TREATMENT

**00789* OLIN TERRACLOR SUPER-X SOIL FUNG W/THIMET SYST. INSECT. GRAN

**00801* OLIN TERRACLOR LIQUID SEED TREATMENT FUNGICIDE

**00806* TERRACLOR

**00809* OLIN TERRACLOR 6.5% PLUS DI-SYSTON 6.5% GRANULAR

**00810* OLIN TERRACLOR SUPER-X-MOLY SEED TREATMENT FUNGICIDE

**00811* OLIN TERACLOR 6.5% SOIL FUNGICIDE WITH THIMET SYSTEMIC INSECTICIDE 6.5

**00813* OLIN TERRACLOR SUPER-X-SEED DUST 20-5

**00814* OLIN TERRA-COAT L-41 SEED TREATMENT FUNGICIDE

**00818* OLIN TERRA-COAT L-205

**00819* OLIN TERRA-COAT WP 6015

**00821* OLIN TERRACLOR 90% DUST CONCENTRATE

**00823* OLIN TERRACLOR SOIL FUNGICIDE 30% GRANULAR

**00824* OLIN TERRA COAT WP-4010 WITH MOLY SEED TREATMENT FUNGICIDE

**CONTINUE REGISTRANT 001258

**00882* OLIN-TERRA COAT LT 2 SEED TREATMENT FUNGICIDE

**00884* OLIN-TERRA-COAT SD-205 SEED DUST FUNGICIDE

**00888* OLIN TERRACLOR SUPER-X WITH GRAPHITE SEED TREATMENT FUNGICIDE

**00914* OLIN TERRA-COAT 2-LF SEED TREATMENT FUNGICIDE

**00943* OLIN TERRACLOR SUPER-X 20-5 WITH GRAPHITE

**00944* OLIN TERRA-COAT 205-LF SEED TREATMENT FUNGICIDE

**00964* OLIN-TERRACLOR 20% GRANULAR SOIL FUNGICIDE

**00982* OLIN TERRA-COAT ZN-2055

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REGISTRANT *NAME AND ADDRESS*

* 001339 COTTON STATES CHEM CO INC
P O DRAWER 157
W MONROE LA 71291

********** PRODUCT NAME **********

**00187* FURROW-TEC TERRACHLOR EMULSIFIABLE CONCENTRATE

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REGISTRANT *NAME AND ADDRESS*

* 001526 A G CHEM-CHEM DIST
ARIZONA AGROCHEMICAL CO.
P.O. BOX 21537
PHOENIX AZ 85036

********** PRODUCT NAME **********

**00411* PHOENIX BRAND GRANULAR INSECTICIDE

**00439* PHOENIX BRAND PCNB 10% GRANULAR

**00492* PHOENIX BRAND GRANULES CONTAINING THIMET 6.5 PLUS PCNB 6.5

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REGISTRANT *NAME AND ADDRESS*

* 002169 PATTERSON CHEMICAL COMPANY INC
1400 UNION AVE
KANSAS CITY, MO 64101

********** PRODUCT NAME **********

**00173* PATTERSON'S BOOT AND CROWN ROT CONTROL

REGISTRANT .*NAME AND ADDRESS*

* 002342 KERR-MCGEE CHEMICAL CORP
MGR PKG & LABELING
KERR-MCGEE CENTER
OKLAHOMA CITY OK 73102

********** PRODUCT NAME **********

**00759* GRO-TONE LAWN FUNGICIDE SPRAY

**00788* 10% THIRAM 10% PCNB

**00836* 20% TERRACHLOR DUST

REGISTRANT *NAME AND ADDRESS*

* 002749 ACETO CHEMICAL COMPANY INC
126-02 NORTHERN BLVD
FLUSHING NY 11368

**00009* PCNB 100

**00289* CAPTAN PCNB 30-30 FUNGICIDE SEED PROTECTANT

REGISTRANT *NAME AND ADDRESS*

* 002935 WILBUR ELLIS CO.
P. O. BOX 1286
FRESNO, CA 93715

********** PRODUCT NAME **********

**00208* RED-TOP TERRACLOR 2 SPRAY

**00357* RED TOP PCNB 10 GRANULAR

**00361* RED TOP THIMET 6.5% SYST. INSECT W/PCNB 6.5% SOIL FUNG GRAN

**00362* RED TOP DI-SYSTON 6.5% SYST. INSECT. W/PCNB 6.5% SOIL FUNG GRAN

REGISTRANT *NAME AND ADDRESS*

* 003125 CHEMAGRO DIV OF BAYCHEM CORP
BOX 4913
KANSAS CITY MO 64120

********** PRODUCT NAME **********

**00070* DEXON - TERRACLOR 35-35 WETTABLE POWDER

**00109* DEXON-TERRACLOR 5-5 GRANULAR SOIL FUNGICIDE

**00145* DEXON TERRACLOR 2.5%-10% DUST

REGISTRANT *NAME AND ADDRESS*

* 003743 SOUTHERN AGRICULTURAL CHEMICALS INC
PO BOX 527
KINGSTREE SC 29556

********** PRODUCT NAME **********

**00251* 101 BRAND P C N B 75 WETTABLE

**00300* 30-30 PLANTER BOX TREATER

**00303* 10-10 PLANTER BOX TREATER

REGISTRANT *NAME AND ADDRESS*

* 004185 SMITH-DOUGLASS DIV.
BORDEN CHEMICAL, BORDEN INC.
5100 VIRGINIA BEACH BLVD.
NORFOLK, VA 23501

********** PRODUCT NAME **********

**00229* CHAMPION LANDPLASTER WITH TERRACHLOR FOR PEANUTS

REGISTRANT *NAME AND ADDRESS*

* 004581 PENNWALT CORP AGCHEM DIV.
PENNWALT TECHNOLOGICAL CENTER
P.O. BOX C
KING OF PRUSSIA, PA 19406

********** PRODUCT NAME **********

**00260* PCNB TECHNICAL

**00264* PCNB FUNGICIDE

REGISTRANT *NAME AND ADDRESS*

* 005522 PRYLINK ADRIAN ASSOCIATION
BOX 339
BABYLON NY 11702

********** PRODUCT NAME **********

**00001* AAPUMA

REGISTRANT *NAME AND ADDRESS*

* 005905 HELENA CHEMICAL CO
CLARK TOWER, 5100 POPLAR AVE, SUITE 2904
MEMPHIS TN 38137

********** PRODUCT NAME **********

REGISTRANT *NAME AND ADDRESS*

* 005967 MOYER CHEMICAL COMPANY
BOX 945
SAN JOSE CA 95108

********** PRODUCT NAME **********

**00055* DEXACLOR 35-35

REGISTRANT *NAME AND ADDRESS*

* 006720 SOUTHERN MILL CREEK PRODUCTS COMPANY INC
BOX 1096
TAMPA FL 33601

********** PRODUCT NAME **********

**00075* SMCP TTC TURF FUNGICIDE

REGISTRANT *NAME AND ADDRESS*

* 007001 OCCIDENTAL CHEMICAL CO
P O BOX 198
LATHROP, CA 95330

********** PRODUCT NAME **********

**00068* BEST TERRACLOR 40 DUST

**00175* TERRACLOR 2 EC

REGISTRANT *NAME AND ADDRESS*

* 007401 VOLUNTARY PURCHASING GROUP INC
PO BOX 460
BONHAM TX 75418

********** PRODUCT NAME **********

**00042* FERTI-LOME LAWN & GARDEN FUNGICIDE

**00084* FERTI-LOME LIQUID FUNGICIDE FOR BROWN PATCH CONTROL

**00163* FERTI-LOME AZALEA-CAMELLIS-GARDENIA PROBLEMS SOLVER

**00197* FERTI-LOME CONTAINING FUNGICIDE

REGISTRANT *NAME AND ADDRESS*

* 009779 RIVERSIDE CHEM COMPANY
P.O. BOX 171199 855 RIDGE LAKE BLVD
MEMPHIS TN 38117

********** *** PROD NAME **********

REGISTRANT *NAME AND ADDRESS*

* 010226 ROCKWOOD CHEM COMPANY
BOX 34
BRAWLEY CA 92217

********** PRODUCT NAME **********

**00005* ROCKWOOD ER SYST T THIMET 6.5% INSECT W/PCNB SOIL FUNG GRAN FOR CO

**00014* ROCKWOOD BRAND LITTLE PEBBLES CONTAINS DI SYSTON 6.5% PCNB 6.5%

**00032* ROCKWOOD BRAND TERRACLOR 2 LB. E.C.

REGISTRANT *NAME AND ADDRESS*

* 010290 PROFESSIONAL CHEMICAL COMPANY INC
P.O. BOX 94071 4517 YALE ST
HOUSTON TX 77018

********** PRODUCT NAME **********

**00021* TERRACLOR 2E

REGISTRANT *NAME AND ADDRESS*

* 010659 OCCIDENTAL CHEMICAL COMPANY
BOX 1185
HOUSTON TX 77001

********** PRODUCT NAME **********

**00034* ZIPP LAWNFOOD 6-12-12 FUNGUS CONTROL

REGISTRANT *NAME AND ADDRESS*

* 010820 QUIMICA ORGANICA DE MEXICO S A
C/O BENEZ ROMERO & CO, INC
103 ROCKWOOD AVE
CALEXICO CA 92231

********** PRODUCT NAME **********

**00001* PCNB TECHNICAL MATERIAL FOR MANUFACTURING PURPOSES ONLY

REGISTRANT *NAME AND ADDRESS*

* 010912 HAYNES CHEMICAL COMPANY
P.O. BOX 30
EAST GRAND FORKS, MN 56721

********** PRODUCT NAME **********

**00001* HAYNES SEED TREAT NO. 1

REGISTRANT *NAME AND ADDRESS*

* 011489 GREEN-UP PLANT FOOD COMPANY
PO BOX 9
NACOGDOCHES TX 75961

********** PRODUCT NAME **********

**00001* GREEN-UP LAWN-CARE PLANT FOOD

****

REGISTRANT *NAME AND ADDRESS*

* 011656 WESTERN FARM SERVICE INC SHELL CHEM COMPANY
1025 CONNECTICUT AVE-STE 200
WASH DC 20036

********** PRODUCT NAME **********

**00029* TERRACLOR* THIMET(R) 6.5 - 6.5

****

REGISTRANT *NAME AND ADDRESS*

* 018773 TURNER SALES & SUPPLY INC
PO BOX 847
TIFTON GA 31794

********** PRODUCT NAME **********

**00002* T-S-P 4 WAY FOR SEED DISEASE CONTROL

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REGISTRANT *NAME AND ADDRESS*

* 033955 ACME DIVISION
PBI GORDON CORP
300 SOUTH THIRD ST
KANSAS CITY, KS 66118

********** PRODUCT NAME **********

**00518* ACME BULB SAVER

Overall Summary

~~Summary of report and important conclusion~~

This report brings together the information on the importance of PCNB to the agricultural industry in the United States. It compares this importance with ~~that of the triggers, resulting in~~ the risks from exposure and ~~reaches~~ forms the conclusion that the value of the benefits are far greater than the detrimental effects of this pesticide and therefore registration of this pesticide should be continued. ~~These~~ decision is based on the following facts:

1. The pesticide is effective against certain soil-borne or seed-borne disease-producing agents such as Rhizoctonia, Sclerotinia, Sclerotium, Ustilago, Plasmodiophora and Streptomyces and against a few pathogens found on lower stems and foliage including Typhula, some Fusarium, and some Puccinia.

2. Rhizoctonia is an important soil-borne fungus which is the most important of the disease-producing agents in the cotton seedling disease complex. It is estimated that if not controlled, this disease complex ~~would~~ cause annual losses of $611,000,000 ~~per~~ year to the cotton industry.

3. Rhizoctonia is also controlled with PCNB on crucifers, potatoes, sugar beets, many ornamental plants and on turf.

4. PCNB is ~~extremely~~ effective in controlling Sclerotium on peanuts, peppers, tomatoes, many ornamentals and garlic.

5. PCNB is ~~very~~ effective in controlling Ustilago sp. on wheat, barley and oats.

6. PCNB is effective in controlling Streptomyces (scab) on potatoes.

7. PCNB gives control of Sclerotinia sp. on many ornamental plants